ANNUAL REPORT
Western Sheep Breeding Laboratory
June 30, 1950

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DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS
OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING
WITH THE WESTERN SHEEP BREEDING LABORATORY
June 30, 1950

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|---|---|
| ARIZONA: | P. S. Burgess, University of Arizona, Tucson. |
| CALIFORNIA: | C. B. Hutchison, University of California, Berkeley. |
| COLORADO: | H. J. Henney, Colorado State Agricultural College, Fort Collins. |
| IDAHO: | Donald R. Theophilus, University of Idaho, Moscow. |
| MONTANA: | Clyde McKee, Montana State College, Bozeman. |
| NEVADA: | C. E. Fleming, Nevada Agricultural Experiment Station, University of Nevada, Reno. |
| NEW MEXICO: | H. R. Varney, Director, New Mexico State College of Agriculture, State College. |
| OREGON: | W. A. Schoenfeld, Oregon State College, Corvallis. |
| TEXAS: | R. D. Lewis, Agricultural and Mechanical College of Texas, College Station. |
| UTAH: | R. H. Walker, Utah State Agricultural College, Logan. |
| WASHINGTON: | Mark T. Buchanan, Washington State College, Pullman. |
| WYOMING: | J. A. Hill, University of Wyoming, Laramie. |

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA: Ernest B. Stanley, Head, Department of Animal Husbandry, College of Agriculture, University of Arizona, Tucson.

CALIFORNIA: James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.

COLORADO: E. Lamar Esplin, Department of Animal Husbandry, Colorado State College of Agriculture and Mechanic Arts, Fort Collins.

IDAHO: C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.

MONTANA: J. L. Van Horn, Department of Animal Husbandry, Montana State College, Bozeman.

NEVADA: Charles E. Fleming, Director, Nevada Agricultural Experiment Station, University of Nevada, Reno.

NEW MEXICO: Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College.

OREGON: F. F. McKenzie, Chairman, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.

TEXAS: Bruce L. Warwick, Department of Animal Industry, Texas Agricultural Experiment Station, Bluebonnet Farm, McGregor, Texas.

UTAH: James A. Bennett, Department of Animal Husbandry, Utah State College, Logan.

WASHINGTON: M. E. Ensminger, Head, Department of Animal Husbandry, State College of Washington, Pullman.

WYOMING: Elden K. Faulkner, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

ROSTER OF PERSONNEL

WESTERN SHEEP BREEDING LABORATORY AND U. S. SHEEP EXPERIMENT STATION
Dubois, Idaho
June 30, 1950

| Name | Rating | Date Entered on Duty | General Duties |
|---|---|---|---|
| Nordby, Julius E. | Animal Husbandman | Mar. 1, 1938 | Director |
| Terrill, Dr. Clair E. | Animal Husbandman | July 3, 1936 | Genetics and Physiology |
| Stoehr, John A. | Animal Husbandman | Aug. 28, 1928 | Operations |
| Kyle, Dr. Wendell H. | Animal Geneticist | July 7, 1949 | Genetics and Statistics |
| Wilson, Lowell O. | Wool Technologist | July 1, 1943 | Wool Technologist |
| Schaefer, Chester F. | Clerk | June 22, 1936 | Chief Clerk |
| Dunn, Harry A. | Clerk | Aug. 22, 1949 | Clerk |
| Hensley, Gladys L. | Clerk | Aug. 4, 1947 | Clerk |
| Taylor, Jessie S. | Clerk | Aug. 25, 1947 | Clerk |
| Twardak, Dorothy M. | Clerk | Sept. 7, 1948 | Clerk |
| Jeffery, Lee C. | Foreman of Farm Laborers | June 7, 1924 | General Maintenance, Pumps, Equipment |
| Rasmussen, Jr., Henry | Farm Laborer | July 1, 1926 | Sub-Foreman |
| Anderson, Daniel | Farm Laborer | Aug. 4, 1947 | Shepherd |
| Bybee, Bert L. | Farm Laborer | April 4, 1949 | Farm Laborer |
| Gates, Kendrick J. | Farm Laborer | Nov. 29, 1948 | Shepherd |
| Goldman, James R. | Farm Laborer | May 1, 1939 | Shepherd |
| Hohman, Max E. | Farm Laborer | April 1, 1935 | Shepherd |
| Howard John H. | Farm Laborer | Oct. 2, 1944 | Camp Tender |
| Ingram, Parley F. | Farm Laborer | Apr. 20, 1947 | Shepherd |
| Lake, Dee H. | Farm Laborer | May 1, 1950 | Farm Laborer |
| Phillips, Walter H. | Farm Laborer | Mar. 16, 1935 | Truck Driver |
| Powell, Fred A. | Farm Laborer | May 11, 1935 | Teamster |
| Swink, Albert B. | Farm Laborer | May 31, 1946 | Farm Laborer |
| Nantz, Mrs. Dorinda R. | Laborer | June 16, 1941 | Janitress & Cook |

## OBJECTIVE

The main ofjective of this Laboratory is to improve sheep for lamb and wool production under range conditions. In the Pursuit of this objective basic breeding methods are employed; heritability analyses are made of the various utility factors, and the selection of breeding animals is based upon production as that is measured under range environment. Emphasis is placed primarily on the quantity and quality of lambs produced; the length, quality and quantity of clean scoured wool, and upon the adaptability and longevity of the sheep.

## RESEARCH LINE PROJECTS

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

    (a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with emphasis on selection for all characters of economic importance.
    (b) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.
    (c) The development of a non-inbred control group.

2. Determination of the inheritance of various undesirable chacteristics of Rambouillet sheep, such as abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stock.

3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including:

    (a) Sexual maturity of Rambouillet ram lambs;
    (b) Quality of semen in relation to fertility; and
    (c) Factors affecting fertility of ewes.

4. Studies on the physiology of wool production of Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in relation to total uniformity of the fleece. Studies are also being made of top making and spinning qualities of various sorts of Rambouillet fleeces.

5. Development of methods for improvement of lamb production in range Rambouillet sheep by studying the various aspects of lamb production in relation to effects of environmental factors, heritability, repeatability, relationship to other important traits and the subsequent incorporation of lamb production in selection indices.

## PUBLICATIONS

The following papers have been published or mimeographed since the beginning of the Western Sheep Breeding Laboratory in 1937. The complete list is included again this year for your convenience. Papers to which the U. S. Sheep Experiment Station has also contributed are starred. A number of contributions have been made to livestock journals and the general press that are not included in this series. They are for the most part adaptations of the regular series prepared for the lay reader.

5. Reproductive Capacity of Rambouillet Ram Lambs as Indicated by Semen Tests. C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 308-310.

* 6. A Preliminary Study of the Relation Between Fleece Characteristics of Weanling and Yearling Range Sheep. W. V. Lambert, J. I. Hardy and R. G. Schott, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 298-303.

* 7. Reproduction in Range Sheep. C. E. Terrill and John A. Stoehr, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 369-375.

* 8. Selection of Range Rambouillet Ewes, C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 333-340.

* 9. Comparison of the Accuracy of Two Methods of Estimating Fineness of Wool Fibers. Ralph W. Phillips, R. G. Schott, J. I. Hardy and H. W. Wolf, Jour. of Agr. Res. 60(5):343-350. Mar.1,1940.

*11. The Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station. Julius E. Nordby. Extension Animal Husbandman, Sept., 1940.

12. Genetics and Range Sheep Improvement. Julius E. Nordby. Scientific Monthly 51:310-320, Oct., 1940.

*14. The Application of a Rapid Comparator Method for determining Fineness and Variability in Wool. Elroy M. Pohle, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 161-168.

*16. Growth in Corriedale and Rambouillet Sheep under Range Conditions. Ralph W. Phillips, John A. Stoehr and G. W. Brier, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 173-181.

*17. Sheep Improvement for Range Production. Julius E. Nordby, Idaho Forester 23, 1941, Forestry School, University of Idaho.

18. A Rapid Method for expressing Medullation in Wool. Elroy M. Pohle, A.H.D. No. 41, May 1941, 6 pp. (Processed).

21. Face Covering in Range Sheep. Clair E. Terrill. A.H.D. No. 49, Nov., 1941, 9 pp. (Processed)

*22. Wool Yield Determination in which Small Samples are Compared with Whole Fleeces. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer, and Glenn W. Brier, A. H.D. No. 50, Jan., 1942, 6 pp. (Processed).

*23. Wool Yields in the Small Side-Sample as Related to Individual whole Fleece Yields in Four Breed-Groups of Sheep. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Jour. of An. Sci. 1(2):137-144, May, 1942.

*24. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(3):221-228, Aug., 1942.

*25. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep. Elroy M. Pohle, Jour. of An. Sci. 1(3):229-235, Aug., 1942.

*26. Staple Length in Relation to Wool Production. Elroy M. Pohle and Henry R. Keller, Jour. of An. Sci. 2(1):33-41, Feb., 1943.

27. Improving Rambouillet Sheep for Western Ranges. Julius E. Nordby, National Wool Grower 33(3):12-7, Mar., 1943.

*28. Staple Length and Its Influence on Shrinkage and Fleece Values. Elroy M. Pohle and Henry R. Keller, National Wool Grower 33(6): 22-24, June, 1943.

30. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, U.S.D.A. Circular 704, August 1944. Revised March 1947.

31. Wool Fineness in Eight Sampling Regions on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott. Jour. of An. Sci. 2(3): 197-208, Aug., 1943.

32. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces, Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 2(3):181-187, Aug., 1943.

33. Fiber Density and Some Methods of its Measurement in the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 2(3):188-196, Aug., 1943.

*34. Estimation of Clean-Fleece Weight from Grease Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle, L. Otis Emik, and Lanoy N. Hazel. Jour. of Agr. Res. 70(1):1-10, Jan. 1, 1945.

*35. Clean-Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel. Jour. of An. Sci. 3(2):159-165, May, 1944.

*36. Shrinkage and Value by Grades for 1943 Range Wool. Elroy M. Pohle and Henry R. Keller. National Wool Grower 34(6):22-23, June, 1944. (Published in other Wool Growers Magazines).

*37. Some Factors Affecting the Blood Phosphorus Level of Range Ewes. W. M. Beeson, Clair E. Terrill and D. W. Bolin, Jour. of An. Sci. 3(2):175-182, May, 1944.

*38. The Accuracy of Measurements and Weights of Sheep. Ralph W. Phillips and John A. Stoehr, Jour. of An. Sci. 4(3):311-316. Aug., 1945.

*39. Monthly Changes in Fineness, Variability and Medullation in Hairy Lambs. Elroy M. Pohle, H. R. Keller and L. N. Hazel, Jour. of An. Sci. 4(1):37-46, Feb., 1945.

40. More Profit in Open Face Ewes. Clair E. Terrill, Mont. Wool Grower 18(1):13, 47. Jan., 1944. (Published in other Wool Growers Magazines).

*41. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yields. E. M. Pohle, L. N. Hazel and H. R. Keller, Jour. of An. Sci. 4(2):104-112, May 1945.

*42. Wool Off-Sorts, Percentage, Shrink, Value. Elroy M. Pohle and Henry R. Keller, Montana Wool Grower 18(6):7, June, 1944. (Published in other Wool Growers Magazines).

43. Effectiveness of Selection on Progeny Performance as a Supplement to Earlier Culling in Livestock. G. E. Dickerson and L. N. Hazel. Jour. of Agr. Res. 69(12):459-476, Dec. 15, 1944.

*44. Looking Forward, The Stabilizing Influence of Research in a Changing Sheep Production Economy. Julius E. Nordby, National Wool Grower 35(6):18-19, 35-36, June, 1945.

45. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. J. E. Nordby, C. E. Terrill, L. N. Hazel and J. A. Stoehr, Anat. Rec. 92(3):235-254, July, 1945.

46. Effects of Some Environmental Factors on Weanling Traits of Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill, Jour. of An. Sci. 4:331-341, Nov., 1945.

47. Heritability of Weaning Weight and Staple Length in Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill, Jour. of An. Sci. 4:347-353, November, 1945.

48. Heritability of Type and Condition in Range Rambouillet Lambs as Evaluated by Scoring, L. N. Hazel and Clair E. Terrill, Jour. of An. Sci. 5:55-61, February, 1946.

49. The Covariance Analysis of Multiple Classification Tables with Unequal Subclass numbers. L. N. Hazel. Biometrics Bulletin 2(2):21-25, April, 1946.

50. Heritability of Face Covering and Neck Folds in Range Rambouillet Lambs as Evaluated by Scoring. Clair E. Terrill and L. N. Hazel. Jour. An. Sci. 5(2):170-179, May, 1946.

53. Effects of Some Environmental Factors on Fleece and Body Characteristics of Range Rambouillet Yearling Ewes. L. N. Hazel, and Clair E. Terrill. Jour. An. Sci. 5(4):382-388, Nov., 1946.

*54. Length of Gestation in Range Sheep. Clair E. Terrill and L. N. Hazel. Amer. Jour. Vet. Res. 8(26):66-72, January, 1947.

55. Refining Methods of Using Opal Blue Stain in Evaluating Ram Semen. L. O. Emik and G. M. Sidwell. Jour. An. Sci. 6(1):67-71, Feb., 1947.

*57. Range Sheep Improvement Through Selection. Clair E. Terrill, Nat'l Wool Grower 36(12):17-19, December, 1946.

*60. Its the Clean Wool in the Fleece That Pays Off. Elroy M. Pohle, Nat'l Wool Grower 37(5):19-20, May, 1947.

*61. Statistical Treatment of Trichostrongylid Eggs. L. Otis Emik, Biometrics 3(2):89-93, June, 1947.

*62. Factors Affecting the Estimation of Concentration of Sperm in Ram's Semen by the Photoelectrometric Method. L. Otis Emik and George M. Sidwell. Jour. of An. Sci. 6(4):467-475, Nov., 1947.

64. Tailless Sperm from Rams. L. Otis Emik and George M. Sidwell. Jour. of An. Sci. 8(1):67-72, Feb., 1949.

*65. Gestation Period in Sheep. Clair E. Terrill and John A. Stoehr. Sheep and Goat Raiser 28(6):23, March, 1948. (Published in other Wool Growers Magazines).

67. Effects of Some Environmental Factors on Traits of Yearling and Mature Rambouillet Rams. Clair E. Terrill, G. M. Sidwell and L. N. Hazel. Jour. of An. Sci. 7(3):311-319, Aug., 1948.

68. Improvement of Sheep for Western Ranges. Julius E. Nordby. To appear as a U.S.D.A. Misc. Publication.

*69. Effect of Feed and Sickness on Wool Growth. Elroy M. Pohle. National Wool Grower. 37(6):9, June, 1947.

*70. High Producing Rams Important. Elroy M. Pohle. National Wool Grower 38(1):21-22, January, 1948.

*71. Fleece Value Increases with Staple Length. Thos. D. Watkins, Jr. National Wool Grower 38(10):17-18, October, 1948. (Published in other Wool Growers Magazines).

*72. Systematic Procedures for Calculating Inbreeding Coefficients. L. Otis Emik and Clair E. Terrill. Journal of Heredity 40(2): 51-55, Feb., 1949.

*73. Increasing Efficiency in Selecting Rams. Clair E. Terrill. To be processed by A. H. Div., Bur. of An. Ind. U.S.D.A.

74. The Relation of Face Covering to Lamb and Wool Production in Range Rambouillet Ewes. Clair E. Terrill. Journal of Animal Science 8(3):353-361, Aug., 1949.

*75. Activating Genetic Concept into Range Sheep Improvement. Julius E. Nordby, Northwest Science. 22(2):60-68, May, 1948.

76. The Effects of Environmental and Hereditary Factors on Trichostrongylid Worm Infestation in Sheep. L. Otis Emik. Jour. of An. Sci. 8(1):73-80, Feb., 1949.

*77. Science as a Means of Sheep Improvement. Julius E. Nordby. Montana Wool Grower 23(1):17, 64, January, 1949.

*78. Dangers and Benefits of Inbreeding. Julius E. Nordby, National Wool Grower 39(1):12-13,40,42, January,1949.

79. Some Profitable Improvements in Rambouillet Sheep. Julius E. Nordby, San Angelo Standard Times, May 1, 1949.

80. More Lambs from Open-Faced Ewes. Clair E. Terrill. National Wool Grower 40(6):15,34, June, 1950.

*81. Wintering Ewe Lambs. John A. Stoehr and Clair E. Terrill. National Wool Grower 40(2):14-15, February, 1950.

*82. Comparison of Elastrator with Cutting for Docking and Castrating. Clair E. Terrill and John A. Stoehr. National Wool Grower 40(3):23 March, 1950.

83. Selecting Rambouillet Ewes for High Lamb Production, Clair E. Terrill. For Journal of Animal Science.

*86. The Semen Production of Rams Under Range Conditions. L. Otis Emik and Clair E. Terrill. For Journal of Animal Science.

*87. The Effect of Successful Embryo Transplantations on the Progress Expected from Selection. W. H. Kyle. For Journal of Animal Science.

88. Effectiveness of Selection for Economically Important Traits of Sheep. Clair E. Terrill. For Journal of Animal Science.

*89. The Influence of Research upon Sheep Production Economy. Julius E. Nordby. San Angelo Standard-Times, April 20, 1950.

*90. Keep Range Livestock on Job Building Soil. A condensation of talk given at the Annual Meeting of the Idaho Soil Conservation District Supervisor's at Lewiston November 7, 1949. Julius E. Nordby. Idaho Farmer January 5, 1950.

91. Increased Usefulness is Evolving to make a Good Breed of Sheep Better. Julius E. Nordby. 1950 Rambouillet Yearbook published by the American Rambouillet Sheep Breeders Association.

## ABSTRACTS

The following abstracts have been published since the beginning of the Western Sheep Breeding Laboratory in 1937. Abstracts to which the U. S. Sheep Experiment Station has also contributed are starred. In general these are abstracts of work that has been or will be published and listed in the regular series of publications.

* 1. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep. Elroy M. Pohle, Jour. of An. Sci. 1(1):60, Feb., 1942.

* 2. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(1):60-61, Feb. 1942.

3. Fineness of Fiber in Eight Sampling Areas on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott, Jour. of An. Sci. 1(4): 356, Nov., 1942.

4. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces. Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 1(4):356, 357, Nov., 1942.

* 5. Estimation of Clean Fleece Weight from Unscoured Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle and L. Otis Emik, Jour. of An. Sci. 1(4):357, Nov., 1942.

6. A Study of the Fiber Density of the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 1(4):357,358, Nov., 1942.

7. Heritability of Yearling Fleece and Body Traits of Range Rambouillet Ewes. Clair E.Terrill and Lanoy N. Hazel, Jour. of An. Sci. 2(4):358-359, Nov., 1943.

* 9. Clean Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 2(4):370, Nov., 1943.

10. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, Jour. of An. Sci. 2(4):371, Nov., 1943.

11. Effects of Some Environmental Factors on the Weanling Traits of Range Sheep. L. N. Hazel and Clair E. Terrill. Jour. of An. Sci. 3(4):432, Nov., 1944.

*12. The Gestation Period of Range Sheep. Clair E. Terrill, Jour. of An. Sci. 3(4):434-435, Nov., 1944.

*13. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yield. Elroy M. Pohle and L. N. Hazel. Jour. of An. Sci. 3(4):452, Nov., 1944.

14. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. Julius E. Nordby, Clair E. Terrill, Lanoy N. Hazel and John A. Stoehr. Anat. Red. 91(4):30, April, 1945.

15. The Construction and Use of a Selection Index for Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill. Jour. of An. Sci. 5(4):412, Nov., 1946.

*16. Factors Affecting the Estimation of Concentration of Sperm in Ram's Semen by the Photoelectrometric Method. L. Otis Emik and George M. Sidwell. Anat. Rec. 97(3):69-70, March, 1947.

*19. The Effects of Environmental and Hereditary Factors on Trichostrongylid Worm Infestation on Sheep. L. Otis Emik and Paul W. Gregory. Journal of Animal Science 6(4):477-478, Nov. 1947.

20. The Relation of Face Covering to Lamb Production in Range Rambouillet Ewes. Clair E. Terrill. Jour. of An. Sci. 6(4):479, Nov., 1947.

*21. Predicting Live Normal Sperm in Rams from Motility Scores. L. Otis Emik, Clair E. Terrill and Geo. M. Sidwell. Jour. of An. Sci. 7(4):511, November, 1948.

*22. The Semen Production of Rams Under Range Conditions. L. Otis Emik and Clair E. Terrill. Journal of Animal Science 8(4):605, Nov., 1949

*23. The Effect of Successful Embryo Transplantations on the Progress Expected from Selection. W. H. Kyle. Jour. of An. Sci. 8(4):607, November, 1949.

## PROGRESS IN INBRED LINES OF RAMBOUILLETS

The 1949 crop of offspring are added in the following table of inbreeding coefficients.

Average Inbreeding Coefficients in Percent

| Year lambed | No. of Potential inbred lines | Sires | Dams | Progeny | Increase of progeny over dams | Highest for progeny of any pen | Highest for any individual offspring |
|---|---|---|---|---|---|---|---|
| 1938 | 20 | 4.0 | 1.1 | 3.9 | 2.8 | 13.3 | 37.9 |
| 1939 | 22 | 7.5 | 3.2 | 7.2 | 4.0 | 30.3 | 58.3 |
| 1940 | 34 | 6.0 | 3.6 | 8.2 | 4.6 | 32.6 | 58.3 |
| 1941 | 36 | 3.3 | 2.7 | 8.6 | 5.9 | 31.2 | 47.3 |
| 1942 | 37 | 4.1 | 4.0 | 8.6 | 4.6 | 28.7 | 39.9 |
| 1943 | 30 | 4.4 | 4.2 | 8.9 | 4.7 | 23.0 | 36.9 |
| 1944 | 30 | 5.0 | 5.0 | 10.3 | 5.3 | 22.8 | 48.0 |
| 1945 | 30 | 6.0 | 5.8 | 14.2 | 8.4 | 26.8 | 42.5 |
| 1946 | 30 | 5.9 | 7.1 | 14.1 | 7.0 | 25.7 | 39.4 |
| 1947 | 30 | 8.6 | 8.1 | 15.6 | 7.5 | 29.0 | 55.2 |
| 1948 | 29 | 14.6 | 9.7 | 17.1 | 7.4 | 30.5 | 42.9 |
| 1949 | 29 | 13.4 | 11.9 | 15.8 | 3.9 | 32.6 | 44.2 |

The average inbreeding of all possible progeny decreased to 15.8 percent in 1949. Five sires and progeny of 4 lines were non-inbred in 1949 as a result of use of outside rams to introduce the polled gene into 4 lines and the open face characteristic into a fifth line. The average inbreeding of the sires decreased also, probably for the same reason. The average inbreeding of the dams increased as the introduction of outside polled rams has not yet affected the inbreeding of the dams.

The average inbreeding coefficient of ram lambs weaned in 1949 was 14.7 percent and of those saved was 14.3 percent. The respective averages for ewe lambs were 15.1 and 14.8 percent.

The most highly inbred lines based on inbreeding of both parents and offspring were 34, 37, 27, 19, 21, 22, 20 and 23. All of these lines are of U. S. Sheep Experiment Station breeding. Considerable relationship existed within these lines when they were initiated in 1937.

The first 6 lines for each of the more important traits are listed in the following table for comparison with similar tables presented

in previous years. These lines were ranked on adjusted averages from weanling offspring in 1949.

| Trait | 1st | 2nd | 3rd | 4th | 5th | 6th |
|---|---|---|---|---|---|---|
| Body weight | 25 | 27 | 36 | 40 | 28 | 26 |
| Body type | 27 | 51 | 25 | 34 | 40 | 36 |
| Condition | 39 | 19 | 36 | 40 | 22 | 34 |
| Staple length | 29 | 37 | 47 | 45 | 39 | 53 |
| Open face | 40 | 50 | 27 | 53 | 44 | 45 |
| Freedom from folds | 20 | 37 | 28 | 47 | 45 | 50 |
| Index | 40 | 27 | 50 | 44 | 25 | 45 |

Nineteen lines were included in the table of which 15 were included last year. Four lines (34, 40, 44, and 47) have ranked in the high six for one or more traits for each of the last 9 years.

## CROSSES OF RAMBOUILLET INBRED LINES

The testing of some Rambouillet lines for both general and specific combining ability was started with matings in the fall of 1949. Ewes were taken at random from 6 of the lines with the largest number of ewes (22, 40, 45, 49, 50, and 51) and were distributed to sires from lines to be tested by use of sires only (21, 23, 25, 43 and 44). The 2 sires from each of these 5 sire lines were each mated to half of the ewes from the sire's line and to 12 ewes from the above 6 lines (2 ewes from each line. Two ewes each from lines 25 and 44 were mated to one sire from each of lines 22, 40, 45, 49 and 51 to provide some reciprocal matings for evaluation of maternal effects.

With this plan information will be obtained on the crossing performance of 11 lines. The plan will need to be continued for 3 to 5 years. At the end of this time any line with unacceptable combining ability may be put to some other use or discarded. The crossline ewe offspring produced would be available for testing the general combining ability of rams from other lines.

## PROPOSED PLAN TO SELECT FOR COMBINING ABILITY IN THE DEVELOPMENT OF SEVERAL RAMBOUILLET INBRED LINES

Recent work with plants and some species of animals indicates that the combining ability of an inbred line can be detected early in its development and can be improved by selection. Selection within a line for combining ability with another line or a tester group is difficult with sheep because of the low reproductive rate. Preliminary attempts at recurrent selection are needed with sheep in order to work out effective ways of carrying on such selection and to point the way for possibly more extensive work later.

It is planned to select within 2 pairs of Rambouillet lines (20 and 27, and 53 and 54) for combining ability with each other. Each year about half of the ewes from each line will be mated with a ram from that line and the other half will be distributed to several rams from the other line. The ram to be used in the line in each succeeding year will be the one having the best cross-offspring. Ewes that produce the best cross-offspring each year will also go back into the line. Only rams without horns will be tested from lines 53 and 54. Crossline ram offspring will be sold and crossline ewe offspring can be used in test crosses of these or other lines.

## UNSELECTED, NON-INBRED CONTROL GROUP

Some thought is being given to the probable service which an unselected control group of sheep might provide in measuring progress in the selected groups of the same breed under the conditions that prevail at this Station. An effort will be made to have the fullest possible information on the theoretical and practical aspects of this matter available for the Collaborators meeting in 1951.

## SELECTED NON-INBRED CONTROL GROUP

This breeding group of Rambouillets was started in the fall of 1947 to serve as a control group to compare improvement resulting from the utilization of inbred lines with that resulting from selection without inbreeding. In the first 2 years it was necessary to use sires from the inbred lines in this group. The lambs born in 1950 were sired by rams selected largely from the control group. Small numbers of control ewes were mated to sires in lines where outside blood was being introduced.

A comparison of the adjusted averages of weanling offspring of the control group with those of the inbred lines for 1948 and 1949 is shown in the following table:

| Group | Year | No. of lambs | Inbr. coef. % | Face covering score | Staple length (cm.) | Weaning Weight (lbs.) | Type score | Condition score | Neck folds score | Index |
|---|---|---|---|---|---|---|---|---|---|---|
| Inbred Lines | 1948 | 871 | 15.8 | 4.18 | 3.16 | 73.97 | 1.95 | 2.21 | 1.21 | 113.5 |
| | 1949 | 838 | 14.9 | 4.04 | 3.34 | 76.59 | 1.94 | 2.67 | 1.20 | 123.3 |
| Non-inbred Control | 1948 | 180 | 1.9 | 4.01 | 3.31 | 72.70 | 1.92 | 2.32 | 1.23 | 116.5 |
| | 1949 | 189 | 1.9 | 4.06 | 3.53 | 75.25 | 1.89 | 2.70 | 1.20 | 123.2 |

As expected there is little initial difference in the two groups in the first 2 years. The non-inbred control group has slightly longer staple, lighter weaning weights, better type, and poorer condition. The differences were all small and with the possible exception of staple length there is probably no real difference in the two groups in this period. The above averages have been adjusted for environmental effects including inbreeding.

## LAMB PRODUCTION OF THE RAMBOUILLET FLOCK

A summary of lamb production for the past 25 years is presented in the following table:

| Year | No. of ewes bred | Percent of ewes pregnant | Percent of lambs born of ewes lambing | Percent of lambs weaned of ewes bred | Average weaning weight | Pounds of lamb per ewe bred |
|---|---|---|---|---|---|---|
| 1924-29 | 1790 | -- | -- | 69.8 | 72.3 | 50.5 |
| 1930-39 | 2294 | 82.3 | -- | 72.9 | 68.1 | 49.6 |
| 1940 | 805 | 87.9 | 122.0 | 86.5 | 79.1 | 68.4 |
| 1941 | 850 | 94.3 | 128.2 | 92.9 | 76.2 | 70.8 |
| 1942 | 1023 | 90.7 | 125.3 | 93.4 | 75.1 | 70.1 |
| 1943 | 903 | 88.0 | 124.9 | 91.6 | 83.4 | 76.4 |
| 1944 | 908 | 92.0 | 129.4 | 94.3 | 75.2 | 70.9 |
| 1940-44 | 4489 | 90.6 | 126.0 | 91.9 | 77.7 | 71.4 |
| 1945 | 962 | 91.7 | 123.4 | 92.2 | 69.8 | 64.3 |
| 1946 | 890 | 94.3 | 134.5 | 100.7 | 70.8 | 71.4 |
| 1947 | 897 | 90.0 | 124.1 | 88.3 | 70.6 | 62.4 |
| 1948 | 882 | 93.6 | 130.7 | 98.8 | 66.3 | 65.4 |
| 1949 | 1002 | 90.4 | 128.4 | 86.1 | 69.5 | 59.8 |
| 1945-49 | 4633 | 92.0 | 128.2 | 93.0 | 69.4 | 64.5 |

With the exception of weaning weight the various aspects of lamb production were poorer in 1949 than in 1948. In fact, over all lamb production as measured by pounds of lamb weaned per ewe bred was the poorest since 1939. Lamb production in the last five years excelled the preceding 5 year period in each aspect except weaning weight and pounds of lamb weaned per ewe bred. Lighter weaning weights in recent years may be partly due to decreasing age at weaning and increased inbreeding. The average age at weaning has decreased from 135 days in 1944 to 126 days in 1949. This would account for about 4 pounds of the change in weaning weight. Increase in inbreeding (about 7% would account for about 3 pounds more of the decrease. The increase in percent of lambs born and weaned would also bring about a slight decrease in weaning weight but should increase pounds of lamb weaned per ewe bred.

## SELECTION PRACTICED ON RAMBOUILLET LAMBS

A Higher proportion of ram lambs and a lower proportion of ewe lambs were saved in 1949 than in 1948. In 1949, 32% of the ram lambs and 69% of ewe lambs were saved as compared with 31% and 75%, respectively, in 1948. Selection Differentials were generally lower in 1949 than last year for ram lambs with the exception of condition and neck folds. Selection differentials were higher for ewe lambs for face covering, Staple length, condition and neck folds.

| | Face covering score | Staple length (cm.) | Weaning Weight (lbs.) | Type score | Condition score | Neck folds score |
|---|---|---|---|---|---|---|
| Heritability | 56% | 40% | 30% | 13% | 4% | 39% |
| RAMS | | | | | | |
| Selection differential | .27 | .17 | 5.59 | .25 | .15 | .10 |
| Expected genetic gain per generation | .076 | .034 | .838 | .016 | .003 | .020 |
| EWES | | | | | | |
| Selection differential | .10 | .06 | 1.75 | .08 | .08 | .05 |
| Expected genetic gain per generation | .028 | .012 | .262 | .005 | .002 | .010 |
| RAMS & EWES | | | | | | |
| Expected genetic gain per generation | .104 | .046 | 1.100 | .021 | .005 | .030 |
| Selection differentials expressed as fractions of a standard deviation. | | | | | | |
| RAMS | .44 | .37 | .66 | .52 | .35 | .33 |
| EWES | .16 | .13 | .21 | .17 | .19 | .17 |

The expected genetic gain per generation from the selection practiced on each sex is the selection differential multiplied by one-half of the heritability. The expected genetic gain from the selection of both sexes is the sum of the values obtained for ram and ewe lambs separately. The last two lines of the table show the fractions of a standard deviation by which the selected lambs excelled the population average for each trait.

Annual genetic improvement depends partly on the length of the generation interval, which is the average age of the parents when their offspring are born. The following table presents the average ages of sires, dams and both parents for lambs born from 1941 through 1949:

| Year lambs were born | Average age of dams (years) | Average age of sires (years) | Average age of sires and dams (years) |
|---|---|---|---|
| 1941 | 4.41 | 4.00 | 4.205 |
| 1942 | 4.37 | 4.13 | 4.250 |
| 1943 | 4.23 | 3.63 | 3.930 |
| 1944 | 4.05 | 3.38 | 3.715 |
| 1945 | 4.01 | 3.40 | 3.705 |
| 1946 | 3.97 | 2.70 | 3.335 |
| 1947 | 4.07 | 2.43 | 3.250 |
| 1948 | 3.94 | 1.97 | 2.955 |
| 1949 | 3.98 | 2.24 | 3.110 |

There was little change in the average age of dams in 1949. The increased age of the sires from 1.97 to 2.24 years appears to have been largely caused by inability to use ram lambs in breeding pens in 1948. None of the Rambouillet ram lambs tested in the fall of 1948 produced semen of good enough quality to permit their use in breeding. The generation length, based on the ages of both parents, is about 26 percent less in 1949 than in 1941 but is about 5 percent greater than in 1948.

The estimated annual genetic improvement from weanling selections is the expected genetic gain per generation from selection of both sexes divided by the generation interval (3.110 years for lambs born in 1949). These rates for each weanling trait from 1943 to 1949 are shown in the following table:

| Year | Face covering score | Staple length (cms.) | Weaning weight (lbs.) | Type score | Condition score | Neck folds score |
|---|---|---|---|---|---|---|
| 1943 | .013 | .019 | .184 | .007 | .001 | .030 |
| 1944 | .020 | .011 | .233 | .009 | .002 | .030 |
| 1945 | .025 | .015 | .319 | .011 | .002 | .020 |
| 1946 | .043 | .016 | .342 | .006 | .002 | .018 |
| 1947 | .041 | .015 | .385 | .007 | .001 | .019 |
| 1948 | .036 | .016 | .404 | .008 | .002 | .006 |
| 1949 | .033 | .015 | .354 | .007 | .002 | .010 |

The rates increased in 1949 for neck folds, remained stationary for condition and decreased for all other traits. Estimated annual genetic improvement in face covering has decreased every year since 1946 but is still higher than in 1945 and before.

## CHECKS ON THE USE OF THE WEANLING INDEX

Checks were made on the importance of deviations from the index in selection of Rambouillet lambs born in inbred lines in 1947, 1948 and 1949. The results for lambs born in 1949 are shown in the following table:

| | Face covering score | Staple length (cm.) | Weaning weight (lbs.) | Type score | Condition score | Neck folds score | Index |
|---|---|---|---|---|---|---|---|
| RAM LAMBS | | | | | | | |
| Actual selection (126 saved of 395 weaned) | .27 | .17 | 5.59 | .25 | .15 | .10 | 10.32 |
| Selection exactly on index (32 lambs switched) | .39 | .18 | 6.44 | .20 | .10 | .13 | 13.40 |
| Selection on index except for 8 lambs with defects not covered by index | .36 | .16 | 6.53 | .19 | .09 | .12 | 12.50 |
| EWE LAMBS | | | | | | | |
| Actual selection (304 saved of 443 weaned) | .10 | .06 | 1.75 | .08 | .08 | .05 | 3.30 |
| Selection exactly on index (54 lambs switched) | .20 | .06 | 2.34 | .10 | .02 | .04 | 5.84 |
| Selection on index except for 14 lambs with defects not covered by index | .17 | .05 | 2.28 | .10 | .03 | .04 | 4.98 |

The third line for each sex in the above table shows the selection differentials that would have been obtained if the index had been followed exactly except where defects not covered by the index, such as overshot jaws, or too much color, were present. This shows that failure to follow the index except for defects, reduced selection differentials for face covering and weaning weight in both sexes, neck folds in ram lambs and type score in ewe lambs and increased selection differentials for condition score and staple length in both sexes, type score in ram lambs and neck folds in ewe lambs. Similar changes were found in the two previous years. The index was not followed in some cases because the lamb with the lower index appeared to be better. It is difficult, when looking at lambs, to adequately account for environmental effects and also to maintain a constant emphasis on the various traits as the index does. Important gains in selection for open face and heavier weights could have been made by following the index more closely.

For instance, switching 24 ram lambs and 40 ewe lambs in favor of the lambs with the higher indexes would have increased selection differentials for face covering by 33 and 70 percent respectively and for weaning weight by 12 and 30 percent respectively.

In general, lambs saved in spite of a poorer index were less inbred, and a higher proportion were from mature dams. Consistent differences were not found for twinning or age at weaning.

It was noted last year that twins raised as twins had lower indexes than single lambs. The discrepancy averaged 5.1 points on the index for the 3 year period from 1946 to 1948. This discrepancy was found to be partly due to a change in the single minus twin difference for neck folds. This decreased from .37 score in 1941-42 to about .08 in 1949. The index difference between singles and twins was corrected in 1949 by adding 5.1 additional points to the indexes of all twins raised as twins.

## EFFECTIVENESS OF SELECTION FOR ECONOMICALLY IMPORTANT TRAITS IN RANGE RAMBOUILLET SHEEP

Preliminary results are available on the amount of selection practiced for weanling traits and the effectiveness of this selection in improving weanling Rambouillet lambs during the period from 1938 to 1948. All records were adjusted for important environmental effects and inbreeding.

Selection differentials, or the differences between the average records of the parents and the average records of the entire populations from which they were selected, were nearly all positive. Selection differentials for sires, have generally increased from 1943 to 1948 for staple length, type, face covering and weanling index. This appears to be due at least in part, to increased accuracy of selection.

Expected genetic progress, obtained by multiplying selection differentials by one-half of the heritabilities, has generally increased for the lamb crops of 1946 to 1948. The expected progress from selection of sires was far greater than from the selection of dams for staple length, (40 to 70 times as great) face covering (8 to 12 times as great) and weight (4 to 11 times as great) and was generally 2 to 3 times as great for type and condition scores. From 81 to 89 percent of the expected genetic progress in the weanling index from 1946 to 1948 came from the selection of sires. The expected annual genetic progress in 1948 from selection of both sires and dams was 0.07 cm. in staple length, 0.84 pound in body weight, 0.018 score in type, 0.004 score in condition, 0.105 score in face covering and 0.047 score in neck folds.

Actual annual progress as shown by the regression coefficients of the traits on years from 1938 to 1948 was definitely positive for staple length, type score and neck folds. There was a tendency for weaning weight and condition score to improve when calculated for the period 1938 to 1948 but to decline when calculated for the period 1940 to 1948 as the years 1938 and 1939 appeared to be poor years. There was a tendency for face covering to become more open since 1940. The weanling index definitely

improved from either 1938 or 1940 to 1948 but the rate of improvement was slightly less than that expected from the selection practiced. This significant increase in the weanling index indicates that overall merit of weanling lambs was improved by selection in the Rambouillet flock of the Western Sheep Breeding Laboratory from 1938 to 1948.

## OFFSPRING OF WESTERN SHEEP BREEDING LABORATORY RAMS SHOW UP WELL IN TEXAS TRIALS

Offspring of 3 rams from line 34 were included in the Texas ram tests ending in 1949. These offspring were younger than average and it appeared that age had a significant effect on some of the traits measured. After adjusting for age, offspring of the 3 rams were above average in every trait including body weight, daily gain, grease fleece weight, clean fleece weight, staple length, face covering and body conformation.

## SELECTION FOR OPEN FACE IN RAMBOUILLETS

The proportion of Rambouillet weanling lambs with various degrees of face covering from 1938 to 1949 are shown in the following table:

| Years | Percent of lambs weaned with | | |
|---|---|---|---|
| | Open faces | Partially covered faces | Covered faces |
| 1938-41 | 12 | 45 | 43 |
| 1942-45 | 11 | 40 | 49 |
| 1946 | 25 | 48 | 27 |
| 1947 | 13 | 43 | 44 |
| 1948 | 12 | 45 | 43 |
| 1949 | 18 | 46 | 36 |

The proportion of lambs with open faces was higher in 1949 than in any previous year except 1946. Since 1947 there has been a tendency for the proportion of lambs with covered faces to decrease and for the proportion of those with partially covered faces to increase.

## SELECTION AGAINST FOLDS IN RAMBOUILLETS

The proportion of weanling Rambouillet lambs born since 1938, with various degrees of neck folds, are shown in the following table:

| Years | Percent of lambs with | | |
|---|---|---|---|
| | No folds | Trace of folds | Moderate to heavy folds |
| 1938-1941 | 8 | 35 | 57 |
| 1942-1945 | 34 | 38 | 28 |
| 1946 | 69 | 21 | 10 |
| 1947 | 56 | 29 | 15 |
| 1948 | 83 | 14 | 3 |
| 1949 | 83 | 13 | 4 |

These results do not indicate any progress in eliminating folds in 1949 as compared with 1948. The flock has evidently already been improved to the point where further progress will be slow. Year to year fluctuations in environmental effects and of possible changes in scoring standards will make it difficult to demonstrate further progress.

## POLLED RAMBOUILLETS

A total of 472 offspring have been weaned through 1949 in the two polled lines (53 and 54) initiated in 1941. Frequency of offspring from the different matings are shown in the following table:

| Parents | Offspring | | | |
|---|---|---|---|---|
| | Horned rams | Rams without true horns | Ewes with knobs | Polled ewes |
| Horned rams x polled ewes | 6 | 10 | 11 | 14 |
| Polled rams x ewes with knobs | 15 | 16 | 11 | 18 |
| Polled rams x polled ewes | 19 | 163 | 37 | 152 |

There was little change in 1948 or 49 from 1947 in the proportion of offspring which apparently carried the polled gene either in heterozygous or homozygous condition. The percent of ram lambs with scurs or short horns has decreased from 86.5 in 1947 to 84.4 and 79.4 for 1948 and 1949 respectively. Only 16 ram lambs without any scur or horn growth have been produced in the 8 year period. Three of these have been used in breeding. One of the 2 completely polled ram lambs born in 1949 was saved for possible use in breeding.

A comparison was made of the scur growth of the sire with that of the offspring. Sires having long scurs or short horns had a higher proportion of ram offspring with long scurs or short horns of those having scurs of any kind than sires with short scurs or depressions. There were small differences in the proportions of polled and horned offspring from the 2 groups of sires. The numbers are too small to draw definite conclusions but it appears to be reasonable that the presence of scurs and the amount of scur growth may be inherited independently. Rams with depressions, scurs, or short horns may all have offspring with depressions, scurs, short horns or horns. There is no clear-cut evidence in these data that rams with depressions are less apt to carry the horn gene than rams with scurs or short horns. Although sires with depressions had fewer horned offspring than sires with scurs or short horns, the former sires were used in the later years when the polled gene was more frequent in the ewes of these lines.

## INCREASING ACCURACY OF SELECTING RAMBOUILLET RAMS

The method used to adjust ram records for age and years was briefly discussed in the 1947 annual report. However, it has been observed that this method penalizes the older rams because it does not consider the changes which previous selections have made in the averages of the older ram groups. Therefore, the method was revised this year to allow for any gain or loss from selection.

Ram records must be adjusted to a common basis with due allowances for year and number of records in order to make accurate selections among them. The following table presents the average grease fleece weights from which adjustments of ram fleece weights were calculated:

| Year of record | | AGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 year | | 2 year | | 3 year | | 4 year | | 5 year | |
| | | No. | Fl.Wt. lbs. | No. | Fl.Wt. lbs. | No. | Fl.Wt. lbs. | No. | Fl.Wt. lbs. | No. | Fl.Wt. lbs. |
| 1946 | Selected Rams | 48 | 10.54 | -- | -- | -- | -- | -- | -- | -- | -- |
| | All Rams | 97 | 9.85 | 38 | 13.85 | 21 | 15.86 | 12 | 16.49 | 2 | 14.12 |
| 1947 | Selected Rams | 62 | 11.90 | 17 | 15.49 | -- | -- | -- | -- | -- | -- |
| | All Rams | 116 | 11.66 | 48 | 15.28 | 21 | 16.90 | 12 | 16.41 | 4 | 15.28 |
| 1948 | Selected Rams | 54* | 11.90 | 32* | 13.88 | 6 | 15.75 | -- | -- | -- | -- |
| | All Rams | 101 | 11.69 | 62 | 13.78 | 17 | 16.05 | 8 | 16.35 | 3 | 16.13 |
| 1949 | Selected Rams | 63 | 11.00 | 37* | 14.18 | 12 | 16.03 | 1 | 16.80 | -- | -- |
| | All Rams | 163 | 10.63 | 57 | 14.10 | 33 | 15.48 | 6 | 15.75 | 2 | 16.50 |
| 1950 | All Rams | 153 | 10.59 | 63 | 13.55 | 38 | 15.23 | 12 | 15.78 | 1 | 15.30 |
| All YEARS | All Rams | 630 | 10.86 | 268 | 14.07 | 130 | 15.78 | 50 | 16.19 | 12 | 15.50 |
| A | | | | | | | 15.98 | | | | |

* The number of selected rams does not equal the number of all rams in the following year because of missing records or purchase of rams without previous records.

For selection purposes, the average value to which all records are adjusted is immaterial because the relative ranking of the animals will be the same regardless of the average value used. The average value arbitrarily chosen here is the average of the 3 and 4 year old average fleece weights (15.98 lbs.) This represents approximately the maximum mature average of rams which are kept to 3 or 4 years of age.

The complete adjustment formula now used is:

B = average of ram's records + A-average of flock records for the same years and age groups + repeatability X selection differential for each year selection was practiced.

Where A = average value to which all records are adjusted.

$$\text{Adjusted value} = \frac{B\,(nr)}{1-r+nr} + \frac{A\,(1-r)}{1-r+nr}$$

where n = number of records and r = repeatability

For example, suppose that the records of a two year old ram in 1950 are being adjusted and that his fleece weights were 13.0 lbs. in 1949 and 15.0 lbs. in 1950. The repeatability of grease fleece weight at this Station is .71.

Then, using values shown in the table,

$$B = 14.0 + 15.98 - \frac{(10.63 + 13.55)}{2} + .71(11.00-10.63) = 18.15$$

The term involving repeatability corrects for the fact that selection practiced on yearlings in 1949 has made the 1950 two year old average (13.55) slightly higher than it would have been without selection.

The adjusted grease fleece weight of this two year old ram is:

$$18.15\,\frac{(2 \times .71)}{1-.71+(2 \times .71)} + 15.98\,\frac{(1 - .71)}{1-.71+(2 \times .71)} = 17.77 \text{ lbs.}$$

This adjusted value may be compared with adjusted values calculated for rams of different ages and years of records with a resulting increase in the accuracy of selection relative to that possible without adjustments. Solution of the formulas may be simplified by the use of tables so that many of the calculations have to be made only once for each group of rams.

## CORRELATIONS BETWEEN TRAITS OF RANGE RAMBOUILLET RAMS

The rams studied were born from 1938 through 1942, the number gradually decreasing from 502 yearlings to 31 5-year-olds, Repeatability of weanling traits at yearling age was 0.76 for weaning weight, 0.70 for

face covering, 0.68 for staple length, 0.54 for neck folds, 0.26 for type, and 0.20 for condition. Repeatability of yearling traits at 2 years was greatest for face covering (0.82), followed by staple length (0.75), body weight (0.71), grease-fleece weight (0.70), clean-fleece weight (0.63), neck folds (0.58), type (0.40), and condition (0.37). Correlations of traits at weaning and 1 year with those at later ages were roughly similar to the above orders and generally declined as the intervening years increased. The adjustment of weanling and yearling records for important environmental effects had practically no effect on the correlations. Significant positive relationships were found at most ages between staple length and clean-fleece weight (0.55 for yearlings) and between grease-fleece weight and clean-fleece weight (0.72 for yearlings). Weanling and yearling staple length showed significant positive correlations with grease-fleece weight (0.34 and 0.30 with yearling grease-fleece weight). Body weight was significantly correlated with the 3 fleece traits. Body weight, type and condition were significantly correlated with one another. Face covering was practically independent of the other traits. A significant negative correlation (-0.12 for yearlings) was found between neck folds and staple length and a significant positive correlation (0.29 for yearlings) was found between neck folds and grease-fleece weight.

## RELATIVE VALUES OF DIFFERENT COMMERCIAL GRADES OF RAMBOUILLET FLEECES

Individual fleece values for the various commercial grades of Rambouillet fleeces within age and sex groups were determined for wool shorn in 1948. Grades were assigned to each fleece by a commercial grader as the fleeces were weighed at shearing time. Clean scoured weights were obtained by scouring entire grade (by the Texas Agr. Exp. Sta.) except for rams where the core bore test (by the Denver Wool Laboratory) for clean yield was used. The appraisal values used were those applied when the wool was sold.

Fine Staple Combing fleeces were most valuable of the mature ewes with an average value of $6.86 per fleece. One-half Blood fleeces from mature Rambouillet ewes averaged $6.75 per fleece and Fine French Combing fleeces averaged $6.06 per fleece. The respective values for yearling ewes were $6.45, $7.10 and $4.96. The added grease fleece weight and higher clean yield of the 1/2 Blood yearling ewe fleeces more than compensated for the lower price per pound. Fine Staple Combing fleeces from yearling rams averaged $7.04 as compared with $6.96 for 1/2 Blood fleeces. It appears that the Fine Staple Combing fleeces were more valuable in Rambouillet mature ewes and yearling rams than 1/2 Blood fleeces while, Fine French Combing fleeces were least valuable. There were no Fine Franch Combing fleeces for yearling rams and all mature ram fleeces were graded as Fine Staple. In Yearling ewes 1/2 Blood fleeces were most valuable, followed by Fine Staple Combing and Fine French Combing fleeces. These values indicate the most profitable kind of Rambouillet fleeces under environmental conditions at Dubois, Idaho on the basis of 1949 wool prices. Staple length appeared to be important as Fine Staple and 1/2 Blood fleeces excelled over Fine French fleeces in each group.

## COMMERCIAL GRADES OF RAMBOUILLET FLEECES

The proportions of the Rambouillet fleeces placed in the various grades at shearing time for the various age and sex groups from 1942 to 1949 are shown in the following table:

| | | Yearling | | | Mature | | |
|---|---|---|---|---|---|---|---|
| | | Fine French (%) | Fine Staple (%) | 1/2 Blood (%) | Fine French (%) | Fine Staple (%) | 1/2 Blood (%) |
| Rams | 1942-45 | 6 | 92 | 2 | 6 | 92 | 2 |
| | 1946 | 7 | 93 | | 4 | 96 | |
| | 1947 | 9 | 91 | | 2 | 98 | |
| | 1948 | | 97 | 3 | | 100 | |
| | 1949 | 6 | 85 | 9 | 10 | 37 | 53 |
| Ewes | 1942-45 | 21 | 75 | 4 | 47 | 50 | 3 |
| | 1946 | 3 | 91 | 6 | 19 | 75 | 6 |
| | 1947 | 9 | 88 | 3 | 33 | 65 | 2 |
| | 1948 | 2 | 91 | 7 | 40 | 54 | 6 |
| | 1949 | 4 | 90 | 6 | 43 | 50 | 7 |

In 1949 there was an increase in the proportion of ram fleeces graded one-half Blood and a slight increase in the proportion of ewe fleeces graded Fine French. Changes in grading standards from year to year may partially account for these changes.

## SORTING OF INDIVIDUAL FLEECES IN 1949

All fleeces were sorted individually in 1949 by one station employee and three commercial wool sorters from the Wool Division. The summary of wool sorting data from 1949 Rambouillet fleeces is given in the following table.

# 1949 WOOL SORTING SUMMARY

| Description | Yearling ewes | | Mature ewes | | Yearling rams | | Mature rams | |
|---|---|---|---|---|---|---|---|---|
| | Average weight per fl. (lbs.) | % of total weight sorted | Average weight per fl. (lbs.) | % of total weight sorted | Average weight per fl. (lbs.) | % of total weight sorted | Average weight per fl. (lbs.) | % of total weight sorted |
| **Main sorts and other matchings** | | | | | | | | |
| **64s and Finer** | | | | | | | | |
| Fine Staple | 4.83 | 63.66 | 3.10 | 32.34 | .68 | 6.75 | .54 | 3.83 |
| Fine French | 1.52 | 19.96 | 3.55 | 37.03 | 5.61 | 55.72 | 4.88 | 34.46 |
| Ave. French | -- | -- | .19 | 1.94 | .07 | .70 | -- | -- |
| Fine Clothing | -- | -- | -- | .01 | -- | -- | .01 | .06 |
| **60s and 62s** | | | | | | | | |
| 1/2 Staple | .32 | 4.21 | .16 | 1.71 | .26 | 2.54 | .53 | 3.75 |
| 1/2 French | .42 | 5.48 | 1.18 | 12.34 | 1.41 | 14.02 | 4.92 | 34.74 |
| 1/2 Clothing | -- | -- | .15 | 1.53 | .10 | .95 | .61 | 4.31 |
| **56s and 58s** | | | | | | | | |
| 3/8 Staple | .01 | .08 | .02 | .18 | .01 | .06 | .01 | .04 |
| 3/8 French | .03 | .43 | .09 | .93 | .03 | .31 | .14 | .98 |
| 3/8 Clothing | -- | -- | .01 | .14 | -- | .01 | .21 | 1.45 |
| **50s** | | | | | | | | |
| 1/4 Staple | -- | -- | -- | .01 | -- | -- | -- | -- |
| **46s and 48s** | | | | | | | | |
| Low 1/4 | -- | -- | -- | .01 | -- | -- | -- | -- |
| **Total Matchings** | 7.12 | 93.83 | 8.46 | 88.19 | 8.16 | 81.06 | 11.84 | 83.63 |
| Main sorts | 5.99 | 78.97 | 7.06 | 73.54 | 7.31 | 72.60 | 10.34 | 73.08 |
| Other Matchings | 1.13 | 14.86 | 1.41 | 14.65 | .85 | 8.46 | 1.49 | 10.56 |
| **Offsorts** | | | | | | | | |
| Burry | .35 | 4.61 | .45 | 4.70 | .81 | 8.08 | 1.48 | 10.44 |
| Stained & Tags | .08 | .99 | .16 | 1.71 | .85 | 8.49 | .67 | 4.75 |
| Paint | .04 | .57 | .52 | 5.40 | .24 | 2.37 | .17 | 1.18 |
| **Total Offsorts** | .47 | 6.17 | 1.13 | 11.81 | 1.91 | 18.94 | 2.32 | 16.37 |
| **Total Sorted** | 7.59 | 100.00 | 9.60 | 100.00 | 10.06 | 100.00 | 14.15 | 100.00 |
| **Total Shorn** | 7.79 | 102.62 | 9.92 | 103.43 | 10.59 | 105.27 | 14.70 | 103.88 |
| **Difference** | -.20 | -2.62 | -.33 | -3.43 | -.53 | -5.27 | -.55 | -3.88 |
| **Number of fleeces** | 474 | | 1191 | | 163 | | 97 | |

Fleeces of mature ewes and rams represent one year's growth. Fleeces of yearling ewes and rams had an average growth period of 409 days. All ewes were crutched in early spring.

The weights and percentages opposite "Difference" indicate differences between shearing and sorting weights and may be accounted for by sweepings, moisture changes, etc. "Main sort matchings" is an arbitrary classification of the largest matching when it weighs at least 25% more than the next largest matching.

The differences in shorn fleece weights between yearling and mature ewes (2.13 lbs.) and between yearling and mature rams (4.11 lbs.) give a rough indication of the important effect of age. The effect of sex on fleece weight is shown by the difference between yearling ewes and rams (2.80 lbs.) and by the difference between mature ewes and rams (4.78 lbs.). However, these differences are complicated by previous selections, inbreeding, length of growth period, and differential contributions of lines to the various groups. Therefore, they represent only rough approximations of the real differences.

A higher percentage of the total wool sorted was classified as offsorts in mature ewes than in yearling ewes. Most of this difference was due to the greater amount of the paint sort in mature ewes. However the branding paint used at this Station has been shown to be completely scourable, permitting classification of paint sort wool as matchings in the future. Other offsorts comprised only 5.60% and 6.41% of the total for yearling and mature ewes, respectively. The percentages of offsorts were much higher for rams and, omitting the paint sort, accounted for 16.57% and 15.19%, respectively, of yearling and mature ram fleeces. Lack of crutching and different range and different winter feed-lot conditions are probably the major reasons for the higher offsort percentages in rams than in ewes.

| | Yearling ewes | Mature ewes | Yearling rams | Mature rams |
|---|---|---|---|---|
| | Percent of total matchings sorted | | | |
| Fineness grade (all lengths) | | | | |
| Fine 64s and finer | 89.13 | 80.89 | 77.93 | 45.86 |
| 1/2 (60s and 62s) | 10.33 | 17.67 | 21.60 | 51.19 |
| 3/8 (56s and 58s) | .54 | 1.42 | .47 | 2.95 |
| Coarser (below 56s) | -- | .02 | -- | -- |
| | Mean fiber diameter in microns (from cross-section) | | | |
| | 21.75 | -- | 21.24 | 23.05 |
| | Percent of total matchings sorted | | | |
| Length (all grades) | | | | |
| Staple | 72.43 | 38.83 | 11.53 | 9.11 |
| French and clothing | 27.57 | 61.17 | 88.47 | 90.89 |
| | Average staple length in inches | | | |
| | 3.22 | -- | 3.31 | 3.37 |

Two main factors, fiber diameter and staple length, determine the classification of matchings. The preceding table gives the percentage distributions of matchings based on grade and length classes separately along with information from cross-sections and staple length measurements.

Mean fiber diameter was determined from shoulder, back and hip samples taken from each sheep just before shearing. These cross-sections show that yearling ewes were slightly coarser than yearling rams. The sorting results are not consistent with the cross-section results on yearling ewes and rams since a greater percentage of matchings from yearling ewes than from yearling rams was sorted as Fine wool. Differences between sorters could account for part of this discrepancy because each sorter did not handle an equal or proportionate number of fleeces from the various age and sex groups. There is also the possibility that sorters may tend to place longer staple fleeces in a coarser grade.

Mature ram fleeces are coarser than yearling fleeces, as indicated by both cross-section and sorting results. No cross-section data are available on mature ewes, but sorting results classify them as slightly finer than yearling rams.

Staple length was measured on all sheep, except mature ewes, just before shearing. Accurate data on the length of wool remaining on the sheep after shearing are not available but the length is probably between one-fourth and one-half inch. A length of 2 1/2 inches is required for wool to be classed as Fine Staple and 3 inches is required for 1/2 Blood or 3/8 Blood Staple.

Sorting results with respect to length are not consistent with actual measurements. Despite the fact that yearling rams have longer staple than yearling ewes, a much higher percentage (72.43) of yearling ewe wool than of yearling ram wool (11.53) was classed as being of Staple length. Only a small part of this difference of 60.90% can be ascribed to the greater percent (11.20) classed coarser than Fine in rams and therefore requiring greater length to be sorted as Staple wool. Sorter differences or the requirements of greater minimum lengths in ram than in ewe fleeces may be causes of the inconsistent results.

Previous data show that staple length in ewes decreases with age. As expected, mature ewes had less Staple length wool than yearling ewes. However, more difference in percentage of Staple length wool between yearling and mature rams would be expected in view of the large difference in amount of Fine wool (32.07%) and the relatively small difference in Staple length (.06 inch).

The sorting results indicate a need for definitive research on the relationships between visual appraisal and objective measurements of wool.

## SUMMARY OF 1949 FLEECE WEIGHTS BY GRADE

| Breed | "FF" No. | "FF" Total | "FS" No. | "FS" Total | "1/2" No. | "1/2" Total | "3/8" No. | "3/8" Total | TOTAL No. | TOTAL Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **MATURE EWES** | | | | | | | | | | |
| RW | 115 | 1110.8 | 136 | 1371.4 | 9 | 93.6 | | | 260 | 2575.8 |
| W | 306 | 2909.4 | 361 | 3587.7 | 57 | 602.9 | | | 724 | 7100.0 |
| S | 91 | 934.0 | 107 | 1103.7 | 13 | 145.7 | | | 211 | 2183.4 |
| TOTAL | 512 | 4954.2 | 604 | 6062.8 | 79 | 842.2 | | | 1195 | 11859.2 |
| Ave. | | 9.68 | | 10.04 | | 10.66 | | | | 9.92 |
| **YEARLING EWES** | | | | | | | | | | |
| RW | 5 | 35.3 | 79 | 609.5 | 5 | 44.7 | | | 89 | 689.5 |
| W | 10 | 70.2 | 248 | 1895.3 | 16 | 120.6 | 1 | 8.1 | 275 | 2094.2 |
| S | 4 | 29.9 | 101 | 829.9 | 8 | 72.5 | | | 113 | 932.3 |
| TOTAL | 19 | 135.4 | 428 | 3334.7 | 29 | 237.8 | 1 | 8.1 | 477 | 3716.0 |
| Ave. | | 7.13 | | 7.79 | | 8.20 | | 8.1 | | 7.79 |
| **MATURE RAMS** | | | | | | | | | | |
| RW | 2 | 28.5 | 8 | 119.7 | 15 | 226.9 | | | 25 | 375.1 |
| W | 6 | 92.3 | 25 | 351.0 | 31 | 469.3 | | | 62 | 912.6 |
| S | 1 | 14.4 | 2 | 29.0 | 4 | 62.1 | | | 7 | 105.5 |
| Misc. | 4 | 48.1 | | | | | | | 4 | 48.1 |
| TOTAL | 13 | 183.3 | 35 | 499.7 | 50 | 758.3 | | | 98 | 1441.3 |
| Ave. | | 14.10 | | 14.27 | | 15.17 | | | | 14.71 |
| **YEARLING RAMS** | | | | | | | | | | |
| RW | 3 | 29.5 | 27 | 284.6 | 2 | 22.5 | | | 32 | 336.6 |
| W | 5 | 46.5 | 74 | 758.2 | 10 | 107.6 | | | 89 | 912.3 |
| S | 2 | 22.9 | 39 | 441.3 | 2 | 23.6 | | | 43 | 487.8 |
| TOTAL | 10 | 98.9 | 140 | 1484.1 | 14 | 153.7 | | | 164 | 1736.7 |
| Ave. | | 9.89 | | 10.60 | | 10.98 | | | | 10.59 |